

# AERONAUTICAL AND ASTRONAUTICAL ENGINEER

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## **DEVELOPMENT AND VERIFICATION OF AN AERODYNAMIC MODEL FOR THE NPS FROG UAV USING THE CMARC PANEL CODE SOFTWARE SUITE**

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The CMARC panel-code is evaluated for the development of an aerodynamic model of the Naval Postgraduate School FROG Unmanned Air Vehicle (UAV). CMARC is a personal computer hosted panel-code software suite for solving inviscid, incompressible flow over complex three-dimensional bodies. A panel model of the NPS FROG UAV is developed to obtain stability derivative data at the cruise flight condition. Emphasis is placed on comparing the CMARC data to aerodynamic models obtained from classical design techniques and parameter estimation. Linearized longitudinal and lateral-directional state-equation models are used to compare the dynamic response of each data set. In addition, CMARC is used to generate static-source and angle-of-attack sensor position corrections. Position corrections are provided in look-up table and curve-fit formats. The aerodynamic model obtained with CMARC demonstrated higher fidelity dynamic longitudinal response than the classical design model. Dynamic lateral-directional response is similar to that obtained from classical design techniques. Adjustment through comparison with flight-test data is still required to optimize the CMARC model. Future studies should concentrate on improving CMARC modeling of fuselage side force through the addition of wake separation lines. Additionally, the propeller disk should be modeled in an attempt to capture the effects of increased dynamic pressure over the horizontal and vertical tail surfaces.

**DoD KEY TECHNOLOGY AREAS:** Air Vehicles, Modeling and Simulation

**KEYWORDS:** Unmanned Aerial Vehicles, UAV, CMARC Panel Method, Ames Research Center, PMARC, Panel Code, Stability Derivatives, Boundary Layer Code, Aircraft Dynamic Response

## **QUANTITATIVE STRUCTURAL RELIABILITY ASSURANCE THROUGH FINITE ELEMENT ANALYSIS**

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Risk assessment of aging aircraft components can be achieved by operational de-rating using a safety factor subjectively selected from experience and heuristics. This investigation involves synthesizing currently available, maturing computer-aided methods into a format of objective quantitative risk assessment. The methodology is applied to quantify the effect of corrosion on P-3C main landing gear lower drag struts. This kind of synthesis is appropriate wherever structural operational risk is a concern. The P-3 has undergone many modifications since the 1950s and the lower drag struts are being scrapped due to internal

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surface corrosion. The corrosion process is random, resulting in pits varied spatially and in severity. These corrosion attributes are merged into a one random variable probability model. The casual relation of the corrosion to structural load is analyzed by finite elements. The structural configuration model input is provided by computer-aided drafting, verified by physical measurement. The effect of corrosion on current strut population reliability, as well as the future, is computed. The conclusion is that even under severe corrosion, compressive buckling is not an issue. All the other failure modes (compressive yielding, tensile yielding, and fracture by fatigue) can be assured by one cold temperature proof test.

**DoD KEY TECHNOLOGY AREA:** Air Vehicles

**KEYWORDS:** Column Buckling, Corrosion, Finite Element Analysis, Probability, Reliability Assurance, Risk Assessment